In re Application of: Gabriel SIRAT et al.
Serial No.: 10/542,865
Filed: January 10, 2006
Final Office Action Mailing Date: June 9, 2008

Examiner: Bryan J. GIGLIO
Group Art Unit: 2877
Attorney Docket: 30238

**In the Claims:**

1-427. (Cancelled)

428. (Currently Amended) An apparatus for analyzing light having at least one wavelength, the apparatus comprising:

(a) a light deflector for deflecting the light so as to provide a deflected light beam characterized by at least one wavelength-dependent angle, respectively, corresponding to the at least one wavelength of the light;

(b) an encoder, which comprises at least one birefringent crystal and which is capable of ~~encoding~~ generating at least one angle-dependent polarization phase-shift in said deflected light beam so as to provide an encoded light beam characterized by at least one angle-dependent polarization phase-shift ~~state~~, respectively, corresponding to said at least one wavelength-dependent angle; and

(c) a decoder, for decoding said encoded light beam so as to determine, for each angle-dependent polarization phase-shift, a wavelength corresponding to said angle-dependent polarization phase-shift ~~at least one spectral component of the light~~.

429. (Previously Presented) The apparatus of claim 428, serving as a component in a system or device selected from the group consisting of a wavelength amplifying system, an optical sensor, a spectrograph, an imaging spectrograph, a time-frequency spectrograph, a telecentric imaging system, an optical storage medium, an optical communication system, a tunable laser system, a lithography system, an optical computing system and a fiber Bragg sensor.

430. (Previously Presented) The apparatus of claim 428, serving for performing at least one operation selected from the group consisting of stabilizing laser radiation, monitoring optical pulses, modulating a light source, discriminating between Raman emission and fluorescence, discriminating between different light

sources, testing a multi-lasers test system, generating frequency multiplexed signals and sensing changes in environmental conditions, influencing said deflected light beam and/or said encoded light beam.

431. (Cancelled)

432. (Currently Amended) The apparatus of claim ~~431~~430, wherein said changes in said environmental conditions are selected from the group consisting of vibrations, changes in temperature, changes in pressure, changes in magnetic field and changes in electric field.

433. (Previously Presented) The apparatus of claim 428, further comprising:

(d) a mechanism for varying at least one parameter representing at least one of said light deflector and said encoder so as to span a discrete basis of signals, each corresponding to one value of said at least one parameter.

434. (Previously Presented) The apparatus of claim 433, wherein said decoder is operable to use said discrete basis of signals for determining wavelengths.

435. (Currently Amended) The apparatus of claim 428, further comprising a beam splitter positioned on a light-path of the light before impingement of the light on said light deflector, for splitting the light into two beams, each having a predetermined polarization.

436. (Previously Presented) The apparatus of claim 435, further comprising at least one polarization rotator, designed and configured so as to rotate a polarization of said deflected light beam and/or a polarization of said encoded light beam.

437. (Previously Presented) The apparatus of claim 428, wherein said light deflector is selected from the group consisting of a grating and a prism.

438. (Previously Presented) The apparatus of claim 437, wherein said grating is characterized by a first grating equation in a first dimension and a second grating equation in a second dimension.

439. (Cancelled)

440. (Currently Amended) The apparatus of claim 42~~38~~39, wherein said encoder is calibrated so as to generate a zero or small polarization phase-shift for a predetermined set of wavelengths and a non-zero polarization phase-shift for wavelengths other than said predetermined set of wavelengths.

441. (Cancelled)

442. (Currently Amended) The apparatus of claim 42~~38~~39, further comprising a first mechanism for varying said angle-dependent polarization phase-shift.

443. (Previously Presented) The apparatus of claim 442, wherein said first mechanism is operable to rotate said at least one birefringent crystal about an axis, so as to vary said angle-dependent polarization phase-shift.

444. (Previously Presented) The apparatus of claim 443, further comprising a first polarization rotator, for rotating a polarization of said deflected light beam from a first polarization orientation to a second polarization orientation.

445. (Previously Presented) The apparatus of claim 444, wherein said first polarization rotator is designed and constructed such that said second polarization orientation substantially equals an orientation of said at least one birefringent crystal.

446. (Previously Presented) The apparatus of claim 445, further comprising a second polarization rotator, for rotating a polarization of said encoded light beam from said second polarization orientation to said first polarization orientation.

447. (Previously Presented) The apparatus of claim 442, wherein said first mechanism is operable to generate a further deflection of the deflected light beam, said further deflection being time-dependent so that said angle-dependent polarization phase-shift varies.

448. (Previously Presented) The apparatus of claim 442, wherein said first mechanism is operable to vary an effective length of said at least one birefringent crystal, thereby to vary said angle-dependent polarization phase-shift.

449. (Previously Presented) The apparatus of claim 448, wherein said first mechanism is capable of applying a voltage on said at least one birefringent crystal, thereby to vary said effective length.

450. (Previously Presented) The apparatus of claim 448, wherein a shape of said at least one birefringent crystalis selected such that when said first mechanism applies a translational motion thereto, said effective length is varied.

451. (Previously Presented) The apparatus of claim 442, wherein said light deflector is a dynamic grating characterized by a grating equation and further wherein said first mechanism is operable to vary said grating equation, thereby to vary said wavelength-dependent angle, thereby also to vary said angle-dependent polarization phase-shift.

452. (Currently Amended) The apparatus of claim 42839, further comprising at least one ~~additional~~ geometrical crystal filter, for polarizing the light prior to impinging of the light on said light deflector.

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453. (Previously Presented) The apparatus of claim 428, wherein said decoder is capable of splitting said encoded light beam into two secondary polarized light beams, and calculating a contrast function between said two secondary polarized light beams.

454. (Previously Presented) The apparatus of claim 428, wherein said decoder is capable of generating a representative time-delay for each polarization state, and using said representative time-delay for determining said at least one spectral component of the light.

455. (Previously Presented) The apparatus of claim 454, wherein said decoder comprises:

(i) a temporal polarization phase-shifter, communicating with an external clock, and capable of accumulating a time-dependent polarization phase-shift to said encoded light beam; and

(ii) a polarization phase-shift analyzer, capable of analyzing said time-dependent polarization phase-shift so as to provide an optical signal having a time-dependent intensity, corresponding to said time-dependent polarization phase-shift.

456. (Previously Presented) The apparatus of claim 455, wherein said decoder further comprises an optical converter, for converting said optical signal to electrical signal.

457. (Previously Presented) The apparatus of claim 428, further comprising at least one filter for filtering a portion of the light, prior to an impingement on said deflector, said encoder and/or said decoder.

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458. (Previously Presented) The apparatus of claim 428, further comprising a first anamorphic prism, positioned so as to reduce a spot size of the light prior to impingement of the light on said deflector.

459. (Currently Amended) The apparatus of claim 428, further comprising an ~~second~~ anamorphic prism, positioned so as to increase angular dispersion of said deflected light beam, prior to impingement of said deflected light beam on said decoder, thereby to optimize a wavelength resolution.

460. (Previously Presented) The apparatus of claim 428, further comprising a low-resolution optical device, for determining a low-resolution spectral range of the light, said low-resolution optical device being characterized by a spectral resolution which is lower than a spectral resolution of said decoder.

461. (Cancelled)

462. (Previously Presented) The apparatus of claim 460, wherein said low-resolution optical device comprises an additional geometrical crystal filter, and further wherein a free spectral range of said additional geometrical crystal filter is different than a free spectral range of said at least one birefringent crystal.

463. (Previously Presented) The apparatus of claim 462, wherein said free spectral range of said additional geometrical crystal filter is substantially larger than said free spectral range of said at least one birefringent crystal.

464. (Previously Presented) The apparatus of claim 460, wherein said low-resolution optical device is capable of directly using said at least one wavelength-dependent angle so as to determine said low-resolution spectral range.

465. (Previously Presented) The apparatus of claim 464, wherein said low-resolution optical device is a position sensing device, whereby a position of said deflected light beam corresponds to a respective wavelength-dependent angle.

466. (Previously Presented) The apparatus of claim 428, wherein the apparatus is characterized by a sub picometer resolution.

467. (Previously Presented) The apparatus of claim 428, wherein the apparatus is characterized by a sub nanometer resolution.

468. (Previously Presented) The apparatus of claim 428, wherein the apparatus is characterized by a total analysis time of from about 1 nanosecond to a few hours.

469. (Previously Presented) The apparatus of claim 428, wherein the apparatus is characterized by a detectivity of from about -80 db to about -0 db.

470. (Currently Amended) An apparatus for measuring a wavelength of a monochromatic light, the apparatus comprising:

(a) a light deflector for deflecting the monochromatic light at a wavelength-dependent angle;

(b) an encoder, capable ~~of encoding~~ generating in the monochromatic light at least one angle-dependent polarization phase-shift ~~according~~ corresponding to said wavelength-dependent angle thereby to provide an encoded light beam; and

(c) a decoder, for decoding said encoded light beam so as to determine ~~the~~ a wavelength corresponding to said angle-dependent polarization phase-shift~~of a monochromatic light~~.

471. (Previously Presented) The apparatus of claim 470, serving as a component in device or a system selected from the group consisting of a wavelength amplifying system, an optical sensor, an optical storage medium, a tunable laser system, and an optical computing system.

472. (Previously Presented) A communications system having a multiplexing apparatus for generating an optical signal characterized by a plurality of wavelengths and a de-multiplexing apparatus, for extracting said information from the optical signal, the de-multiplexing apparatus comprising:

(a) a light deflector for deflecting the light so as to provide a deflected light beam characterized by a plurality of wavelength-dependent angles, respectively, corresponding to the plurality of wavelengths of the optical signal;

(b) an encoder, capable of generating at least one angle-dependent polarization phase-shift in said deflected light beam so as to provide an encoded light beam characterized by a plurality of angle-dependent polarization phase-shift, respectively corresponding to said plurality of wavelength-dependent angles; and

(c) a decoder, for determining the plurality of wavelengths of the optical signal based on said plurality of polarization phase-shifts.

473-474. (Cancelled)

475. (Currently Amended) A Bragg sensor system for detecting vibrations, the Bragg sensor system comprising the apparatus of claim 428.~~having an apparatus for analyzing light having at least one wavelength, the apparatus comprising:~~

~~(a) a light deflector for deflecting the light so as to provide a deflected light beam characterized by a plurality of wavelength dependent angles, respectively, corresponding to the plurality of wavelengths of the optical signal;~~

~~(b) an encoder, capable of encoding said deflected light beam so as to provide an encoded light beam characterized by a plurality of angle dependent~~

~~polarization states, respectively, corresponding to said plurality of wavelength-dependent angles; and~~

~~(c) a decoder, for decoding said encoded light beam so as to determine the plurality of wavelengths of the optical signal, thereby to detect vibrations of said light deflector and/or said encoder~~.

476. (Currently Amended) A method of analyzing light having at least one wavelength, the method comprising:

(a) deflecting the light so as to provide a deflected light beam characterized by at least one wavelength-dependent angle, respectively, corresponding to the at least one wavelength of the light;

(b) encoding said deflected light beam using at least one birefringent crystal so as to generate at least one angle-dependent polarization phase-shift in said deflected light beam, thereby providing~~e~~ an encoded light beam characterized by at least one angle-dependent polarization phase-shift~~—state~~, respectively, corresponding to said at least one wavelength-dependent angle; and

(c) decoding said encoded light beam so as to determine, for each angle-dependent polarization phase-shift, a wavelength corresponding to said angle-dependent polarization phase-shift;

thereby analyzing ~~at least one spectral component of~~ the light.

477. (Currently Amended) A method of measuring a wavelength of a monochromatic light, the method comprising:

(a) deflecting the monochromatic light at a wavelength-dependent angle;

(b) encoding the monochromatic light using at least one birefringent crystal so as to generate in the monochromatic light at least one angle-dependent polarization phase-shift corresponding ~~according~~ to said wavelength-dependent angle, thereby providing an encoded light beam; and

(c) decoding said encoded light beam so as to determine ~~the~~ a wavelength ~~of~~ corresponding to said angle-dependent polarization phase-shift;

thereby measuring the wavelength of the monochromatic light.

478. (Previously Presented) A method of sensing changes in environmental conditions affecting a wavelength of light, the method comprising executing the method of claim 476 for determining wavelength changes in the light, thereby sensing the changes in environmental conditions.

479. (Previously Presented) Apparatus for analyzing light having at least one wavelength, the apparatus comprising:

(a) a grating characterized by a first grating equation in a first dimension and a second grating equation in a second dimension, for deflecting the light so as to provide a deflected light beam characterized by at least one wavelength-dependent angle, respectively, corresponding to the at least one wavelength of the light;

(b) an encoder, capable of encoding said deflected light beam so as to provide an encoded light beam characterized by at least one angle-dependent polarization state, respectively, corresponding to said at least one wavelength-dependent angle; and

(c) a decoder, for decoding said encoded light beam so as to determine at least one spectral component of the light.